A Simulation Architecture to Support Intratheater Sealift Operations

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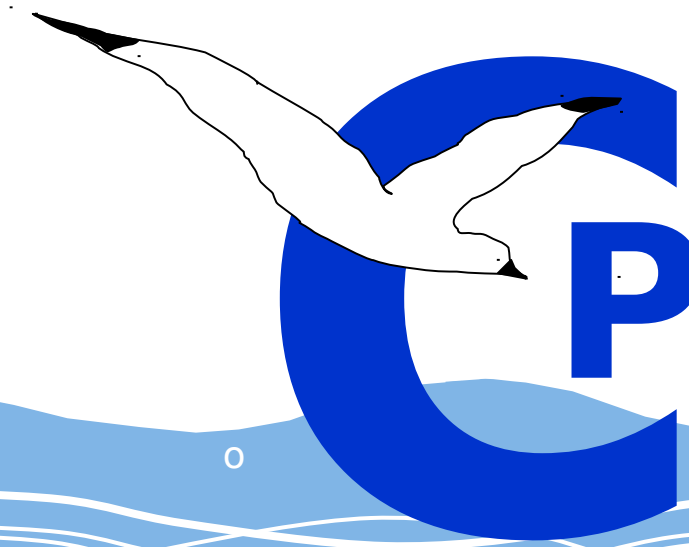
Historical Development

- CPortS (supporting PORTSIM project)
  - Complete SPOD capability
- Network of cargo terminals
  - Demonstrated in current work
- JLOTS model integrated into CPortS
  - Model developed, simulation still under consideration

$\forall \Rightarrow$ Intratheater Sealift Model

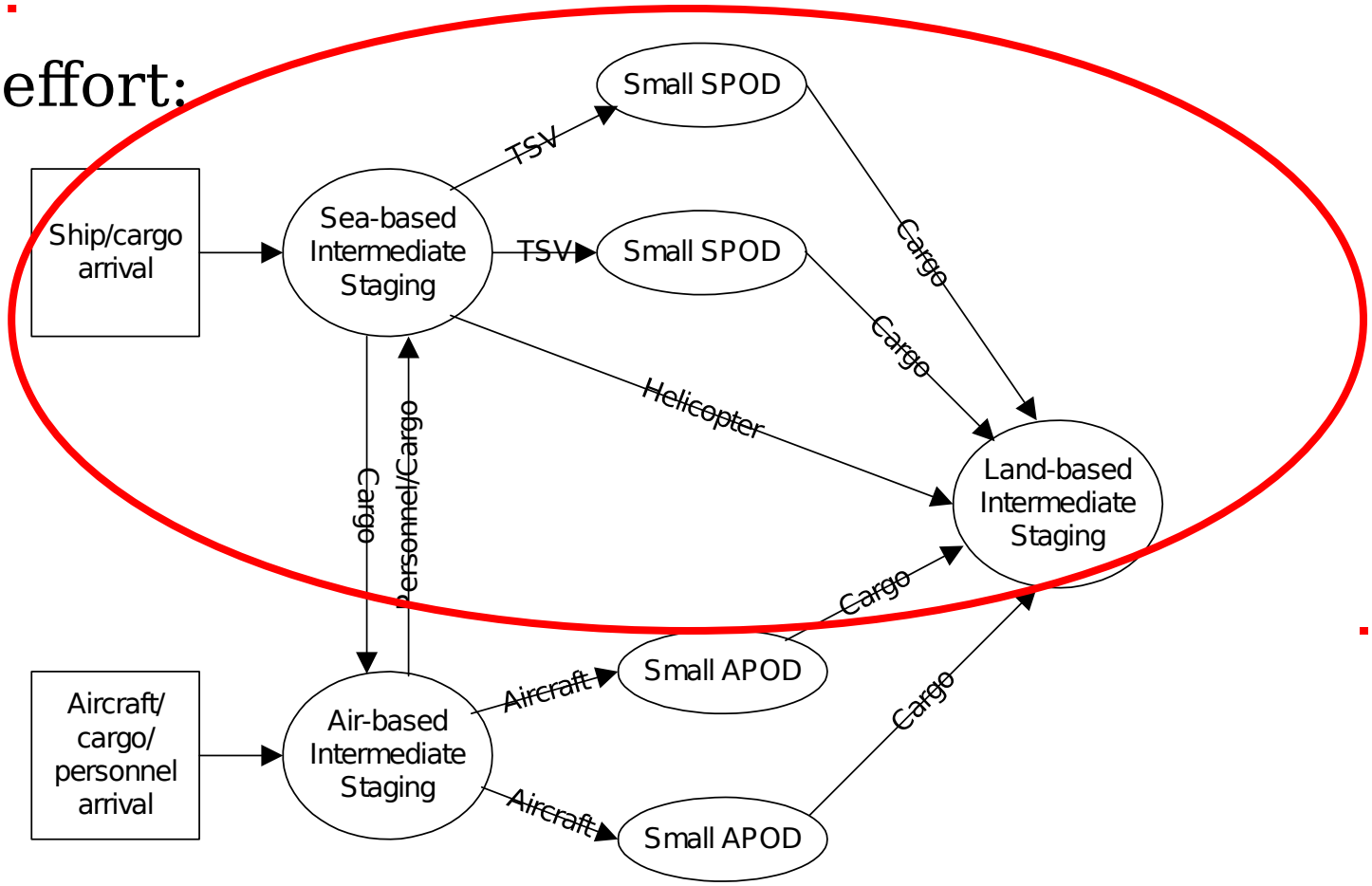
A Configurable Port Simulation



CPortS

Joint Intratheater Sealift and Airlift Model

Current effort:



Simple Mathematical Model
Best Case Analysis

Given lower bound TSV cycle time

$$T = (T_L + T_{TL} + T_U + T_{TU})$$

Where:
- T_L : Loading time
- T_{TL} : Time to travel under load
- T_U : Unload time
- T_{TU} : Time to travel under no load

Upper limit on # TSVs before saturation

$$N_{bound} = \min\left[N_L \cdot \left(\frac{T}{T_L}\right), N_U \cdot \left(\frac{T}{T_U}\right)\right]$$

Where:
- N_L : Number of loading sites
- N_U : Number of unloading sites

Lower bound time to closure

$$T_C = \left[\left(\frac{\#\text{of loads}}{N_{effective}}\right) \bullet T\right] - T_{TU}$$

Where:

$$\#\text{of loads} = \max\left[\frac{SQFT(cargo)}{SQFT(TSV)}, \frac{STON(cargo)}{STON(TSV)}\right]$$

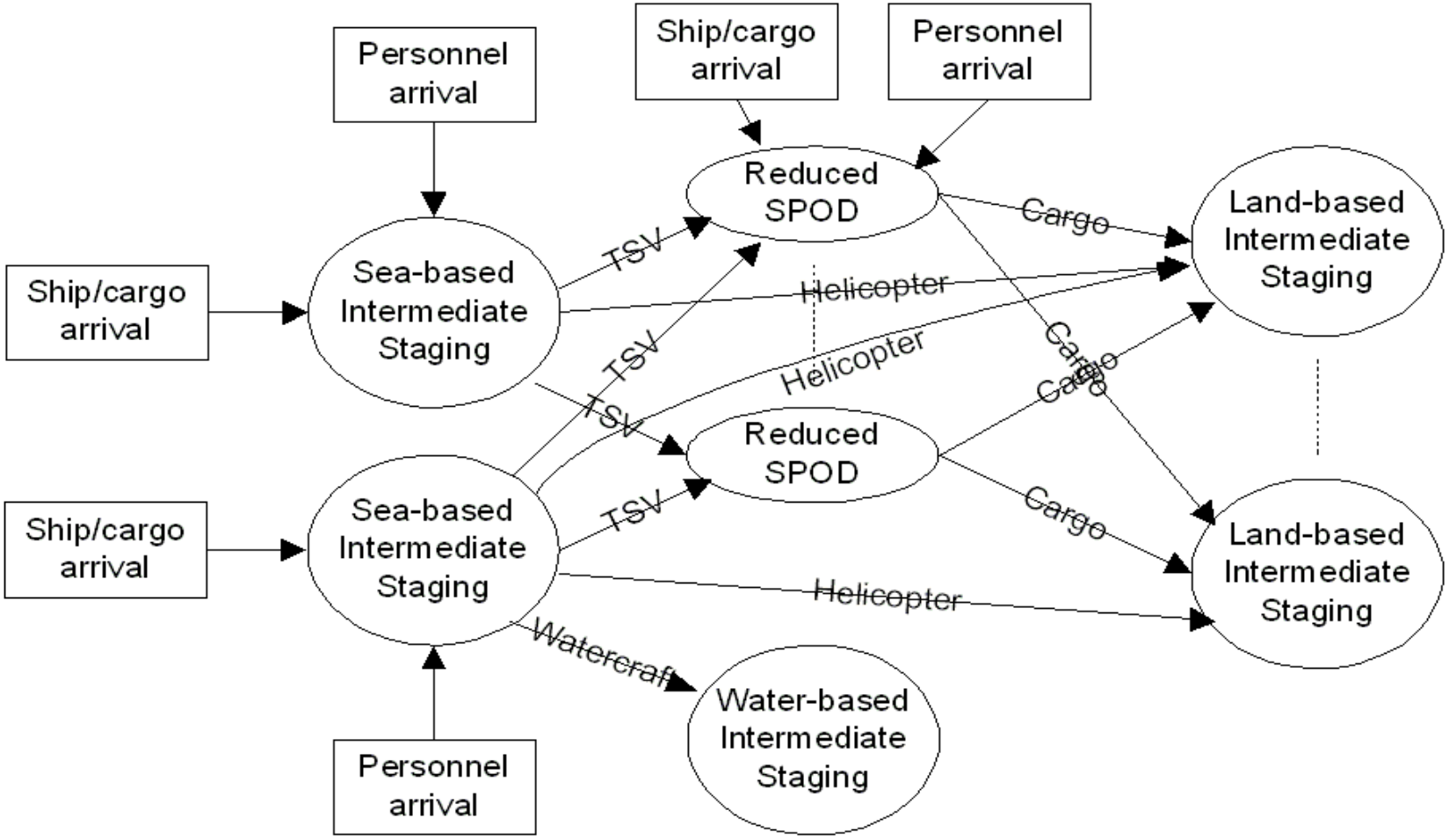
(minimum # of loads)

$$N_{effective} = \min(N_{bound}, N_{TSV})$$

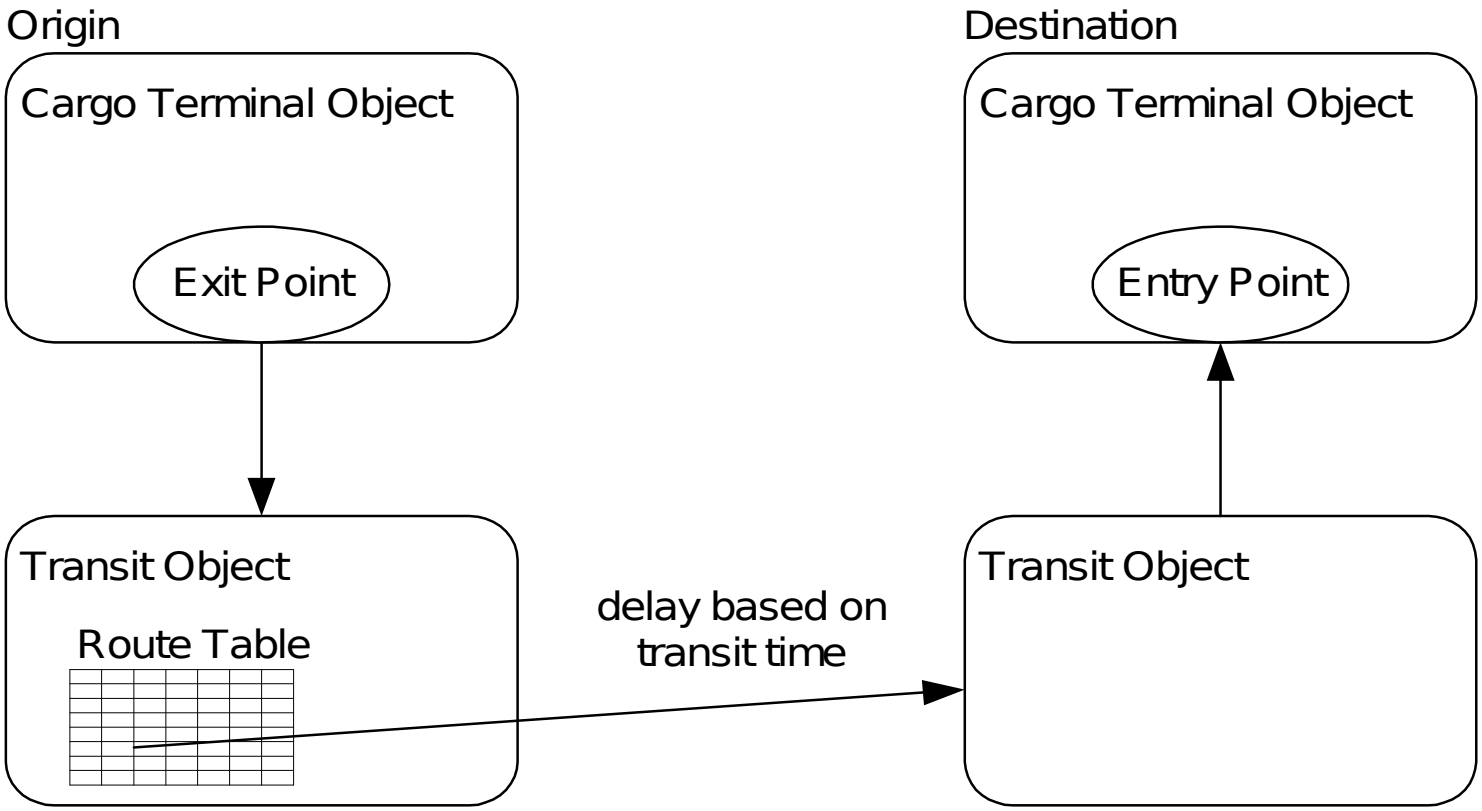
Simulation Model

- Focuses on cargo terminals
  - Intermediate staging bases
  - Reduced SPODs
  - Statistical model of transit times
- Models:
  - Cargo entity level
  - Resources: drivers, cranes, cargo handlers, etc.
  - Infrastructure: berths, staging, etc.

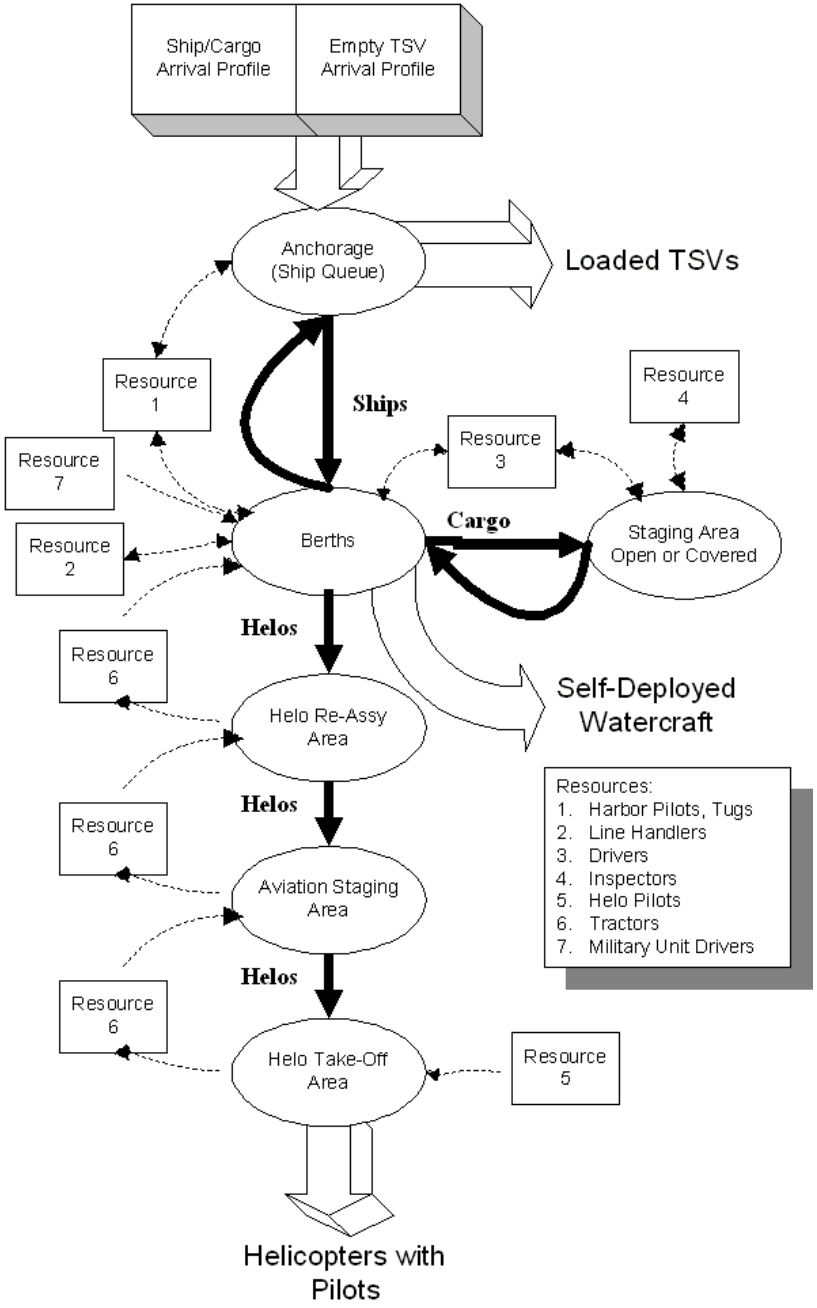
Intratheater Sealift Model



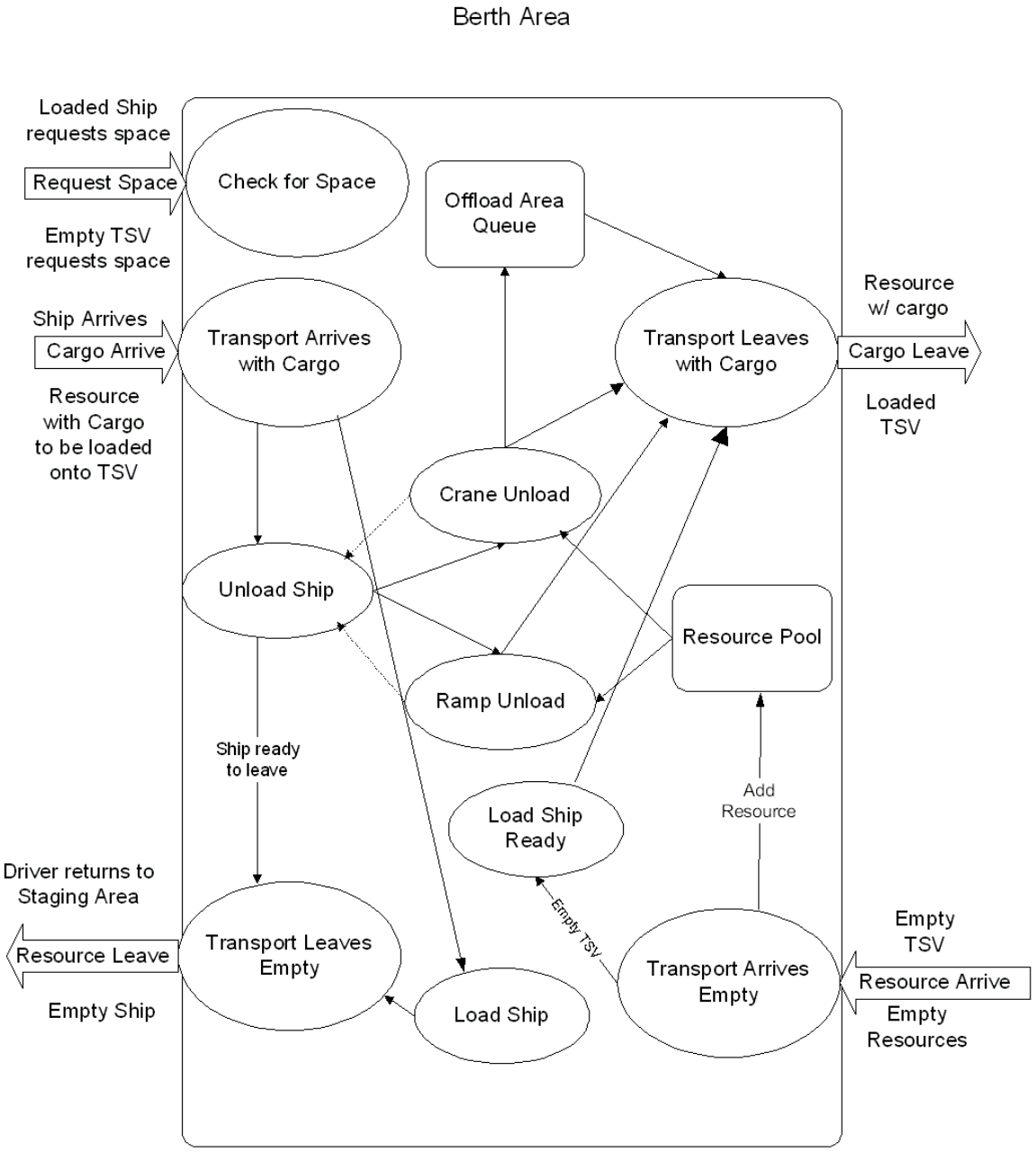
Network of Cargo Terminals



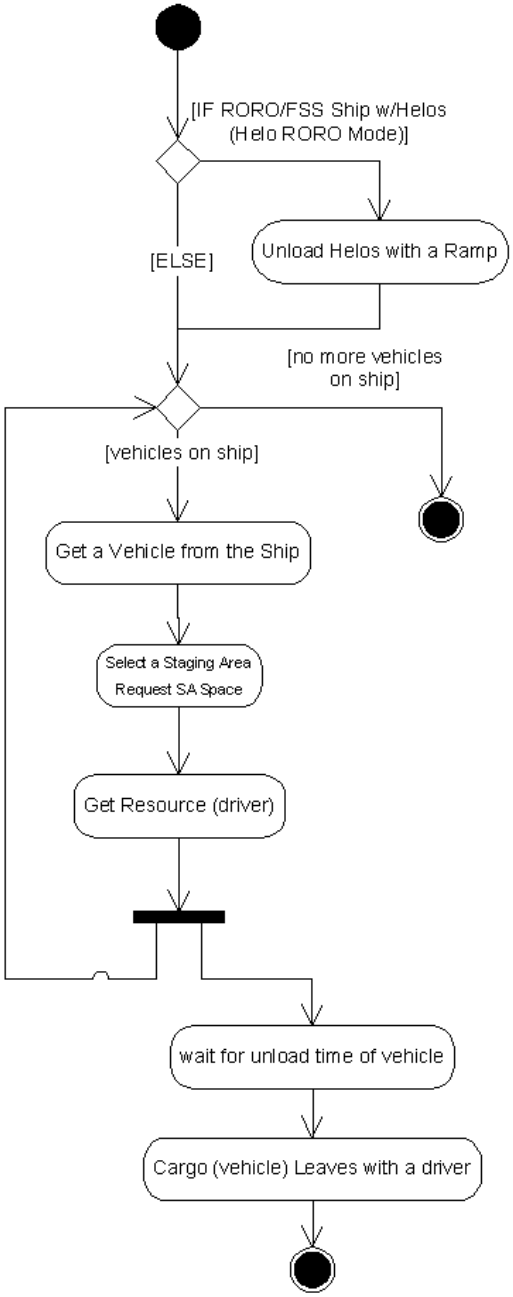
Macro-Level ISB Model



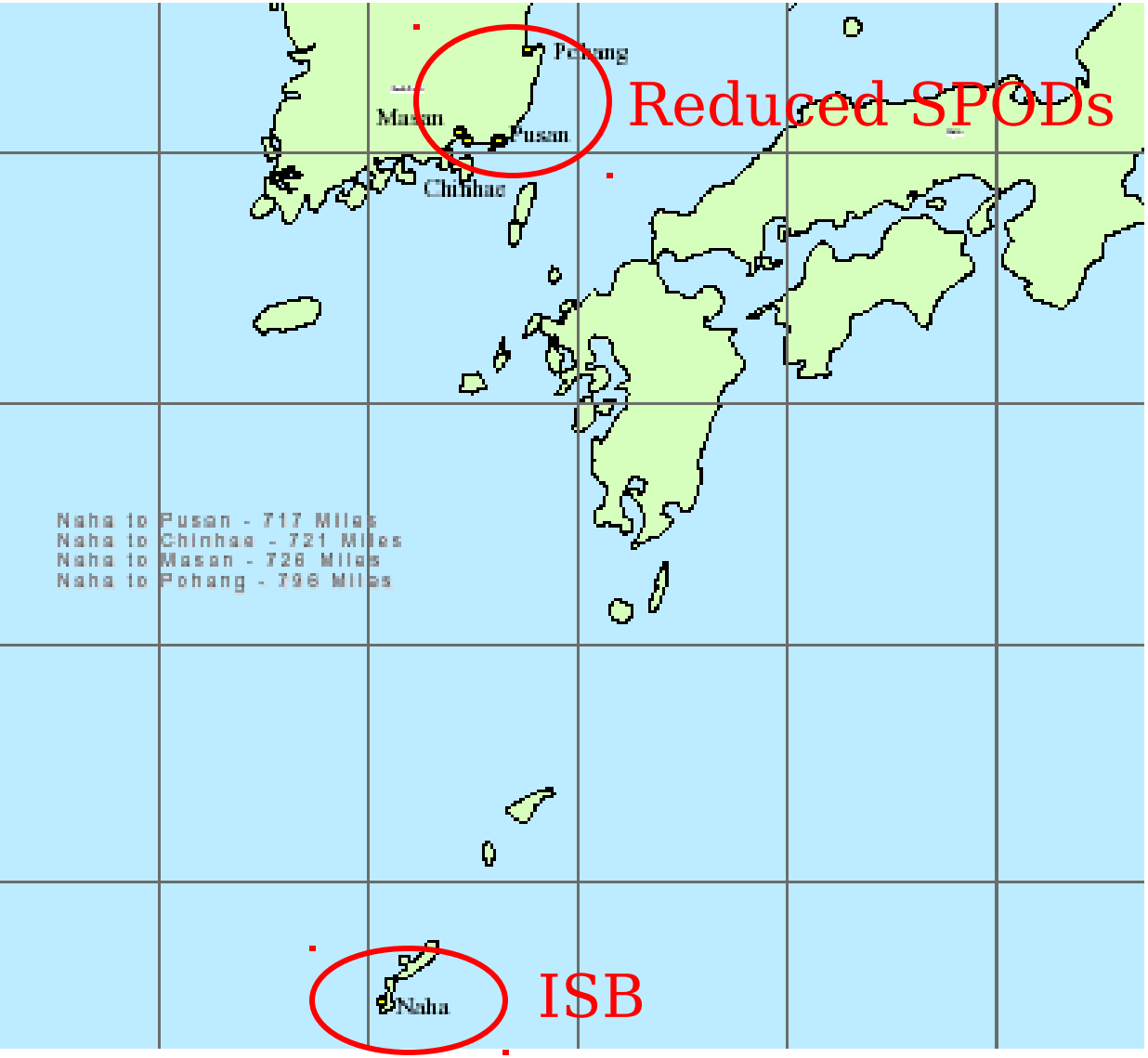
Berth Model


Berth Area
Loaded Ship requests space
Request Space
Check for Space
Offload Area Queue
Empty TSV requests space
Ship Arrives
Cargo Arrive
Transport Arrives with Cargo
Transport Leaves with Cargo
Resource w/ cargo
Cargo Leave
Loaded TSV
Resource with Cargo to be loaded onto TSV
Crane Unload
Unload Ship
Resource Pool
Ramp Unload
Ship ready to leave
Load Ship Ready
Add Resource
Driver returns to Staging Area
Resource Leave
Transport Leaves Empty
Empty TSV
Transport Arrives Empty
Empty TSV
Resource Arrive
Empty Ship
Load Ship
Empty Resources

Ramp Unload Process



Fictitious Scenario



Reduced SPODs restricted to minim capabilities – small berth and staging

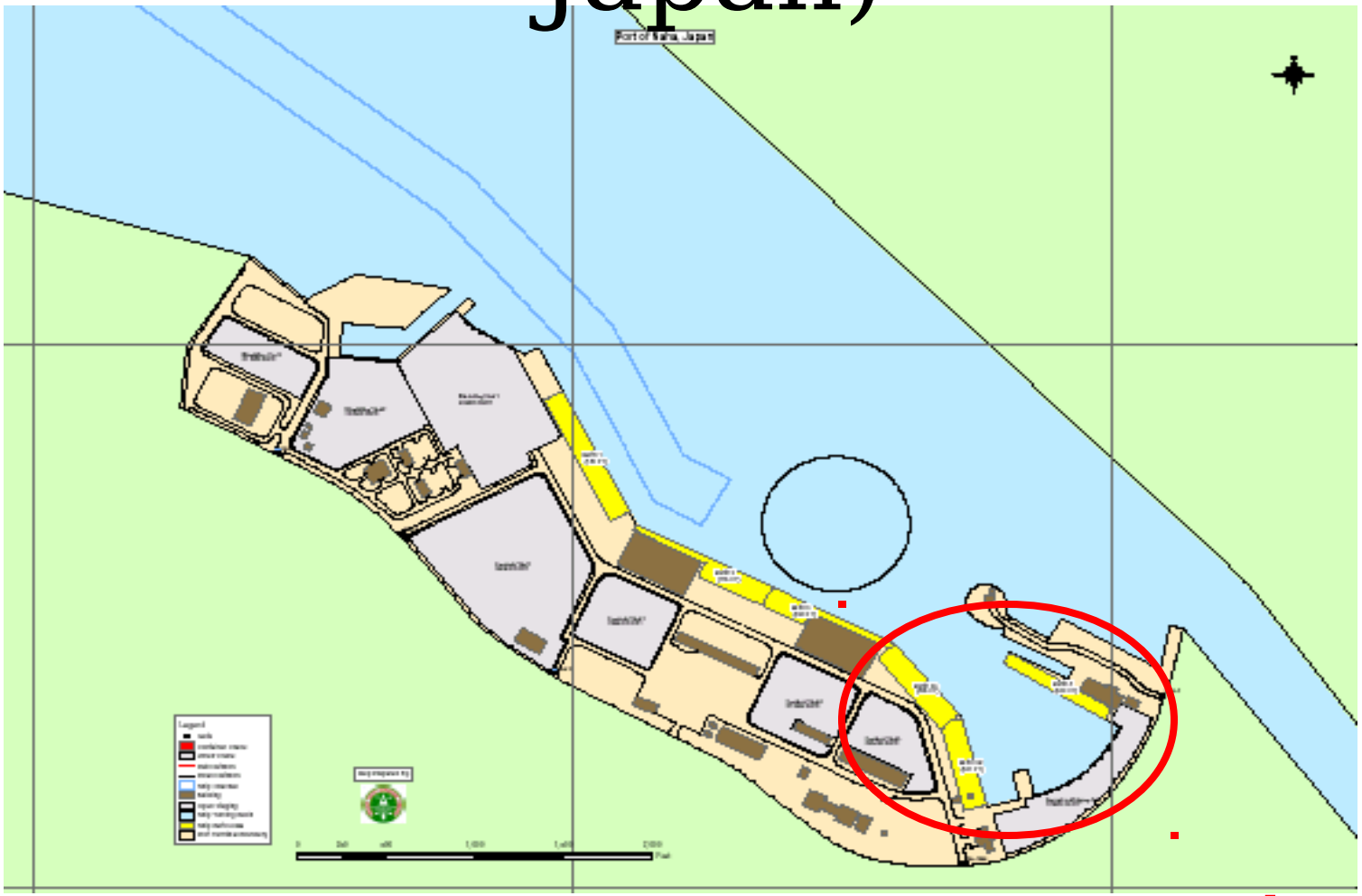
Scenario solely for demonstrating capabilities.

TSV Characteristics Studied

TSV Size	Small TSV	Large TSV
Payload Area	12,000 Sq. Ft.	25,000 Sq. Ft.
Payload Weight	600 STons	1,250 STons
Speed	35 Knots	42 Knots
Length	300 Ft.	420 Ft.
Beam	87 Ft.	89 Ft.
Draft	12 Ft.	15 Ft.

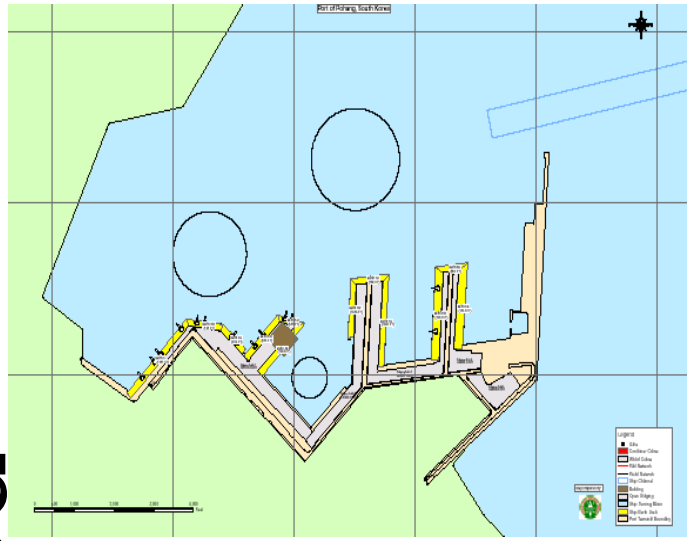
TSV Characteristics

ISB Modeled (Naha, Japan)

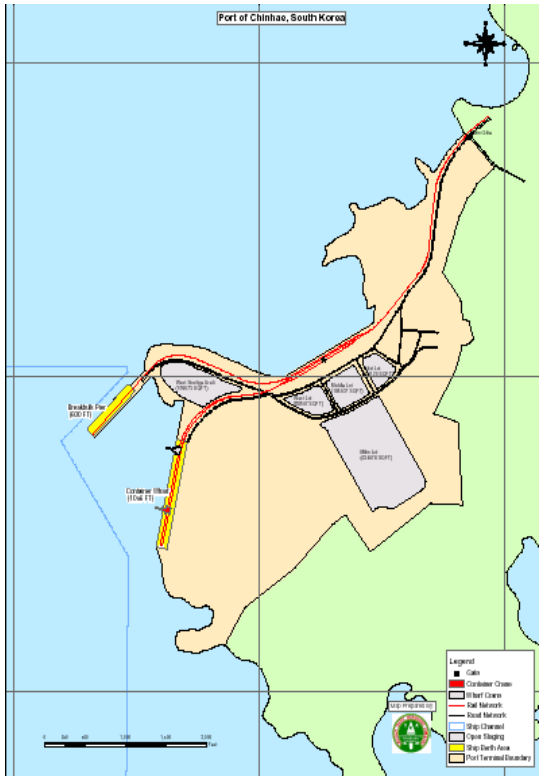


Portion Utilized

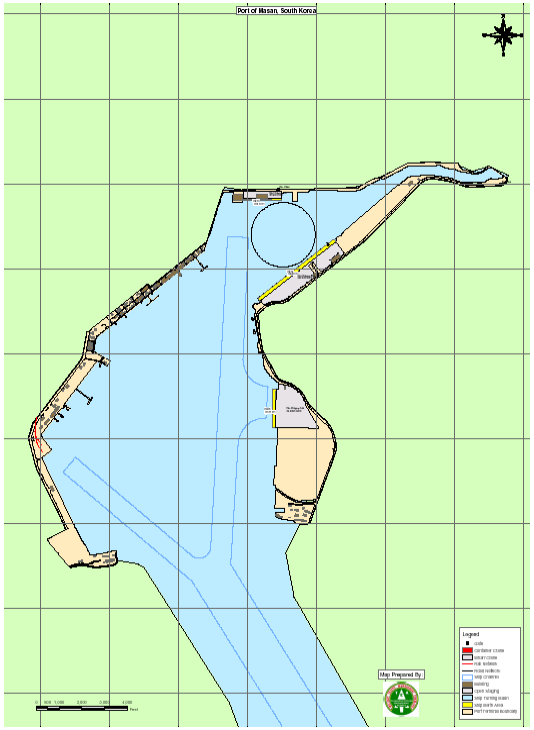
Reduced SPODs Modeled



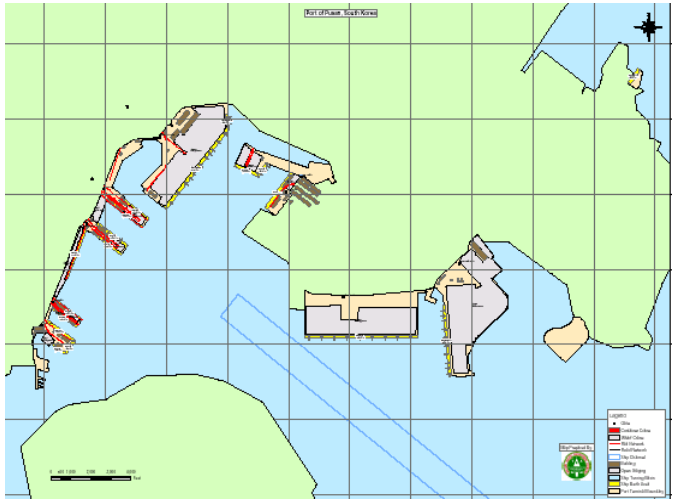
(a) Port of Pohang, South Korea.



(b) Port of Chinhae, South Korea.



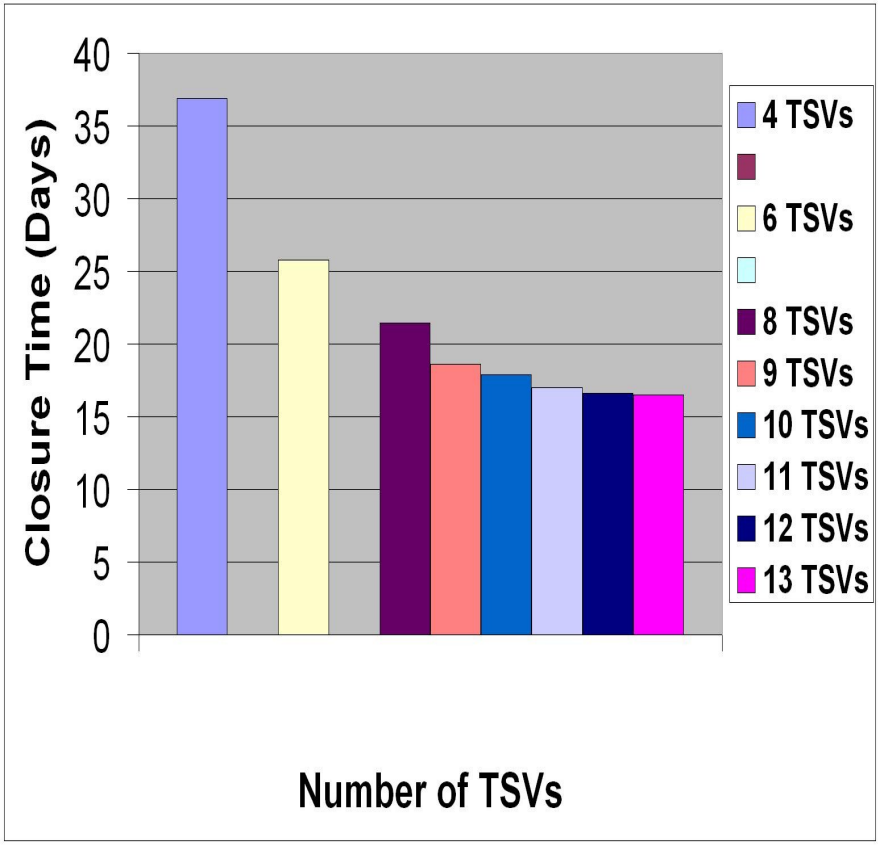
(c) Port of Masan, South Korea.



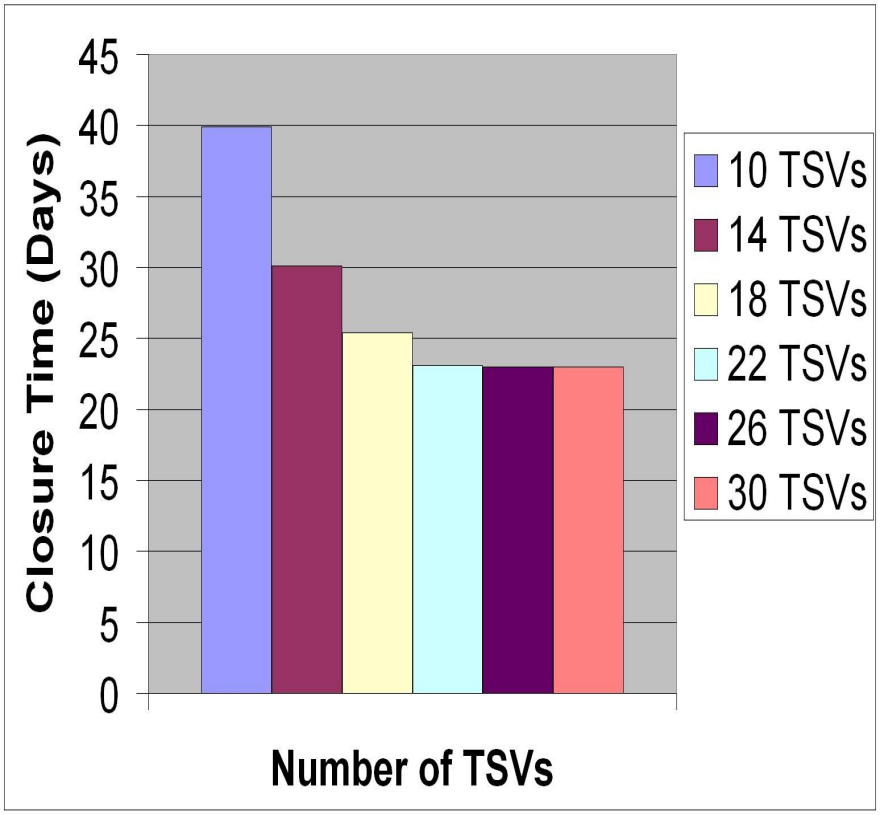
(d) Port of Pusan, South Korea.

Closure Time vs. # of TSVs

Large TSVs

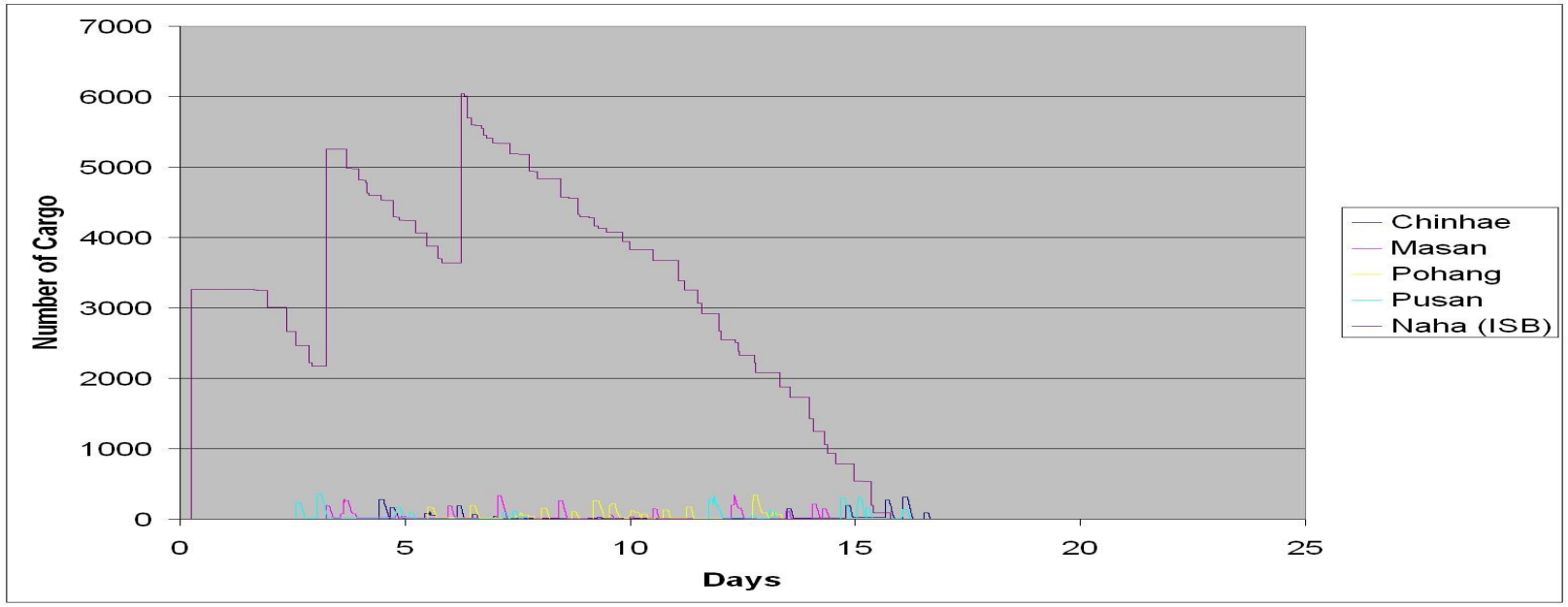


Small TSVs

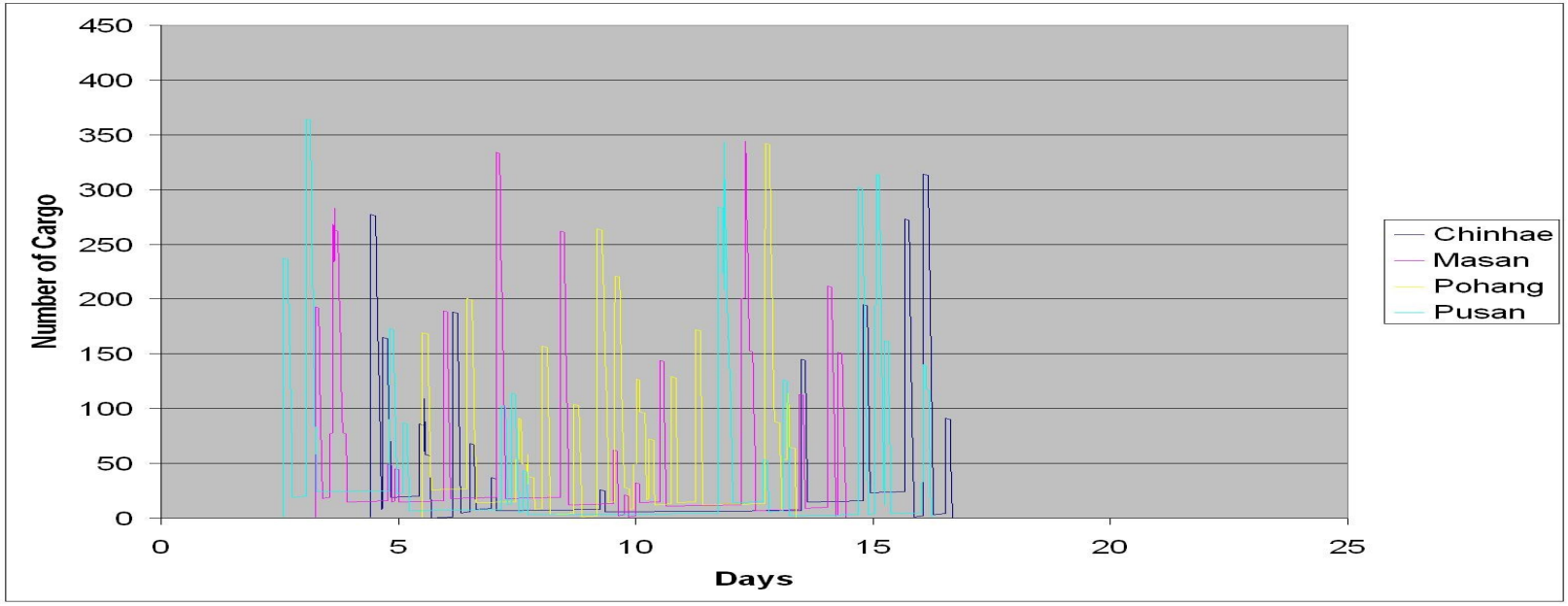


Note: scenario ports accepted classes of TSVs

Port Profiles (# pieces of cargo)

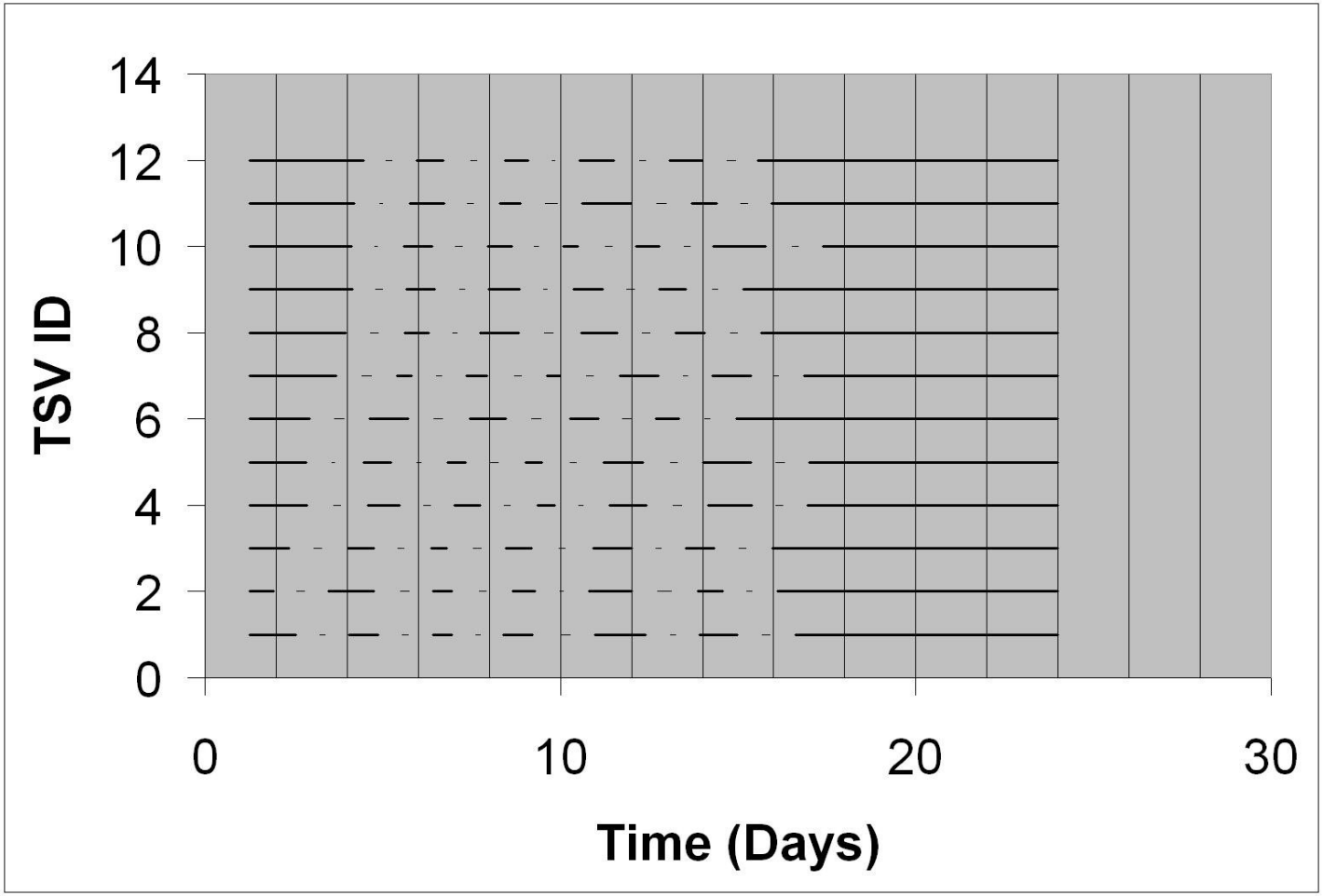


(a)



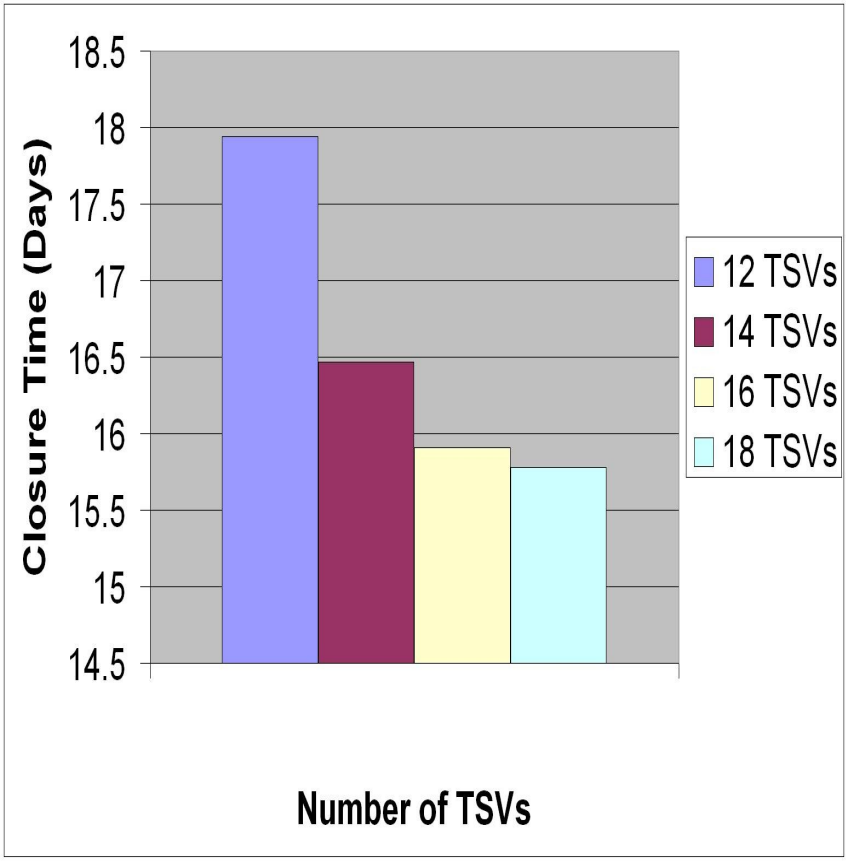
(b)

TSV Activity Diagram



Port Enhancement Studies

- Model – programmatic events
- Scenario bottleneck at ISB, not reduced SPODs
- Enhanced port by adding TSV loading capabilities at ISB



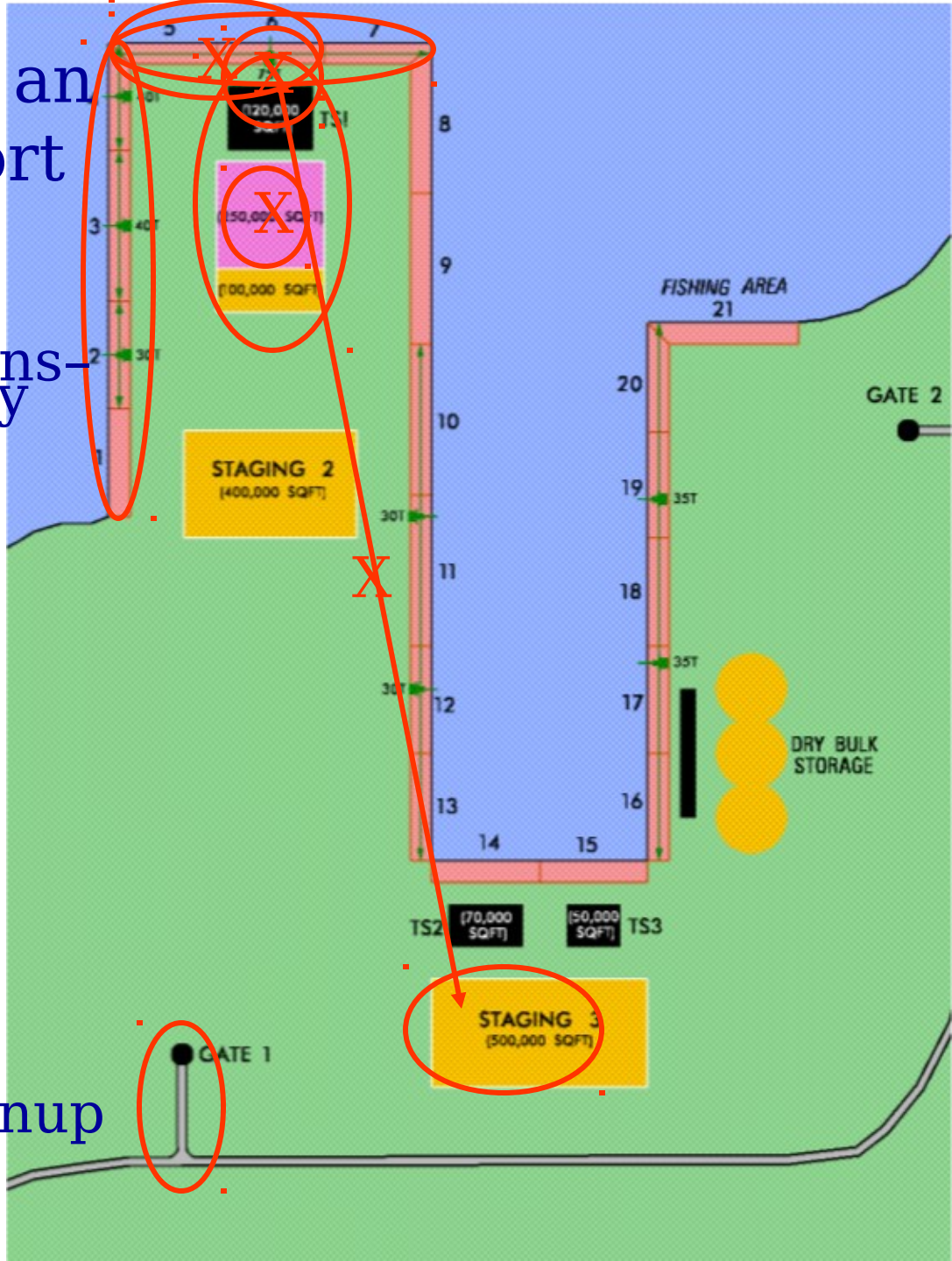
Ongoing Developments

- Integrated installation and SPOE modules
  - Scenario now being driven by cargo from Pearl Harbor
- Disruptive events
  - Programmatic events
  - Opposite usage from port enhancements

Disruptive Events for an Example Fictitious Port

Example disruptions:

- Infrastructure reductions– Available to the Military
  - berth space
  - staging capacity
- Resource reductions–
  - cranes
  - container handlers
  - personnel
- Process times–
  - crane offload time
  - transit time
  - dwell times –
    - accounts for cleanup

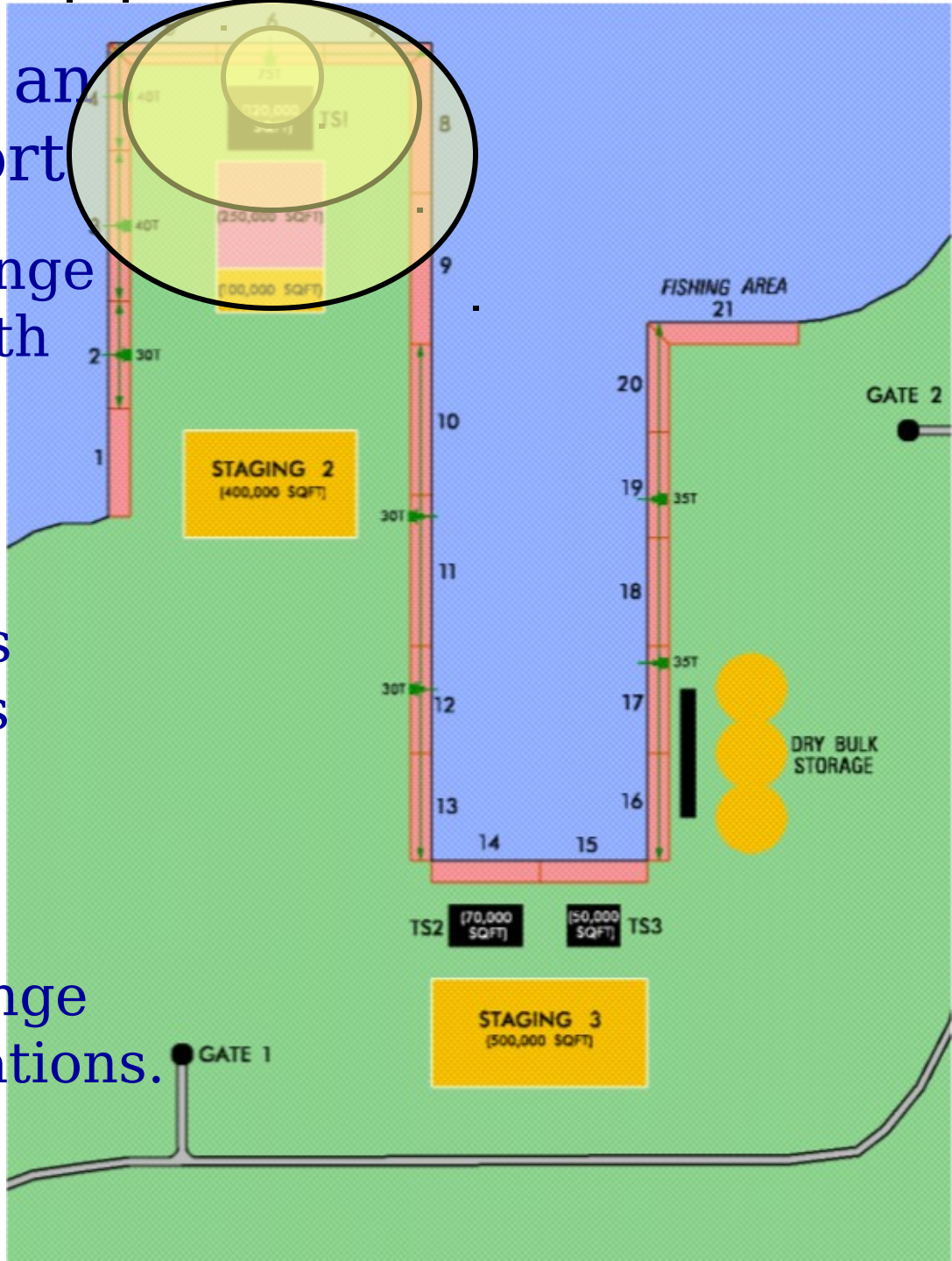


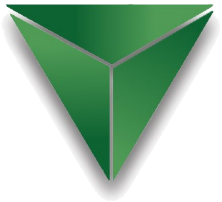
Disruptive Events for an Example Fictitious Port

Potential to model change in impact over time with varying effects

- Study:
  - Impact
  - Security strategies
  - Cleanup strategies
  - Network impact
  - Etc.

Strategies employed extendable to a wide range Of discrete event simulations.





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Questions?